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V

THE FAUNA OF A MEDIAL TERTIARY FORMATION AND THE ASSOCIATED HORIZONS OF NORTHEASTERN MEXICO*

BY

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AND

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INTRODUCTION

Professor E. T. Dumble has submitted to the California Academy of Sciences for identification and study some Tertiary fossils from the gulf coast of Mexico in the vicinity of Tampico and Tuxpan, the greater part of which were collected by Professor E. T. Dumble himself, Professor W. F. Cummins, Mr. Sands, and Mr. Muir. In all cases the fossils were carefully marked and the localities well described. The collection localities are scattered along the coast both north and south of Tampico for a distance of 500 miles.

The echinoids are particularly abundant and will doubtless prove to be excellent horizon determiners, because at several localities, they are associated with mollusks whose ranges are

* The name "San Fernando," originally applied by Prof. E. T. Dumble to these beds, has been found to be preoccupied. Professor Dumble now proposes that they be called the San Rafael beds.

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known. Some of the echinoids found here were described by Cotteau from the West Indies. The most widespread beds recognized in the medial are correlated with the Bowden and Gatun horizons and their fauna is an inshore facies of the Bowden. Some of the echinoderms described by Cotteau from the beds of supposed Eocene age are associated with characteristic mollusks of the Bowden stage, thus showing that the age of certain Antillean horizons are an inshore facies of the Bowden, upper Oligocene or lower Miocene.

The senior writer is responsible for the identification of the Pelecypoda, Gastropoda and some of the Echinoidea. The junior writer determined most of the echinoids and the descriptions of new species are written by him.

Stratigraphy

The geology of this region has recently been discussed by Professor Dumble.[1] The accompanying map illustrates the general relations of the Tertiary beds north of Tampico. See Plate 16, which was kindly supplied by Prof. Dumble.

Professor Dumble has described this region as follows:

> Overlying the beds we have here referred to the Eocene, we find a series of yellow sands, clays and calcareous beds which carry an Oligocene fauna. We have called these the San Fernando from the fine exposures of the beds in the vicinity of the town of that name on the Conchos River. (Locality x4.) As will appear, these beds all belong to the Upper Oligocene and up to this time no beds of the Lower Oligocene, like those of the Buenavista River region with *Orbitoides papyracea,* etc., have been recognized in the area north of the Tamaulipas Range. From our present knowledge it would seem that while the Lower Eocene deposits show a gradual overlapping southward until the Conchos is reached, the Oligocene, on the contrary, shows an overlapping northward to the same region, so that along the Conchos the uppermost beds of the Oligocene are in contact with the members of the Eocene there exposed.
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> In the region of San Jose de las Rusias, which occupies the extreme southern portion of this area, we have numerous exposures of the Upper Oligocene. (Localities x3, x5, x21, x22, and x23 are representative of this region. R. E. D.) It apparently immediately overlies the Cretaceous and is penetrated by eruptive rocks which are connected with or extend eastward from the Tamaulipas Range.
>
> The lower beds of the Oligocene in this region are yellow clays, which are altered in places and appear as hardened shales, and clayey limestones carrying *Cristellaria, Nummulites,* corals and molluscan forms followed by yellow sands and clays with an extensive fauna. The beds have a general southeast dip. At San Rafael on the Zarizal River, at the extreme south-

[1]Dumble, E. T. The Tertiary Deposits of Northeastern Mexico, Proc. Cal. Acad. Sci., 4th series, Vol. V, No. 6, pp. 163-193, 1915.

ern end of the district, the contact of the eruptives with the yellow clays is well shown.

Lying four to six miles east of San Rafael there is a range of hills 300 to 400 feet in height, composed of alternating beds of yellow clays and clayey limestones carrying poorly preserved molluscan forms together with great numbers of *Cristellaria,* corals and some *Nummulites.* Among the corals collected here, Dr. T. W. Vaughan determined *Favosites* (?) *polygonalis* Duncan, *Goniastrea antiguensis* Duncan, *Acropora* (?), sp., *Orbicella,* n. sp., and *Goniopora,* sp., very similar to or identical with an Antiguan species. These, he says, indicate an Upper Oligocene horizon about equivalent to the Chattahoochee of Georgia.

Around the San Jose de las Rusias Ranch the beds which are exposed show considerable disturbance. Immediately at the ranch the beds, which are fossiliferous sandstones, dip northwest at a high angle. Northeast of the ranch a hill 60 feet high shows beds of yellow clay overlain by hard calcareous sandstone which weathers into rounded masses. A great number of corals occur within the clays and in the sandstone. Dr. Vaughan reports *Orbicella cellulosa* Duncan, and *Meandrina,* n. sp., from this locality. A short distance north of this hill is another in which the basalt has come up through the Oligocene beds which are here impregnated with asphalt. To the east of the ranch, some few miles, there is a range of hills 400 feet high capped with the Coquina, and lying to the east of the range another volcanic hill. North of the Soto la Marina the same clays and limestones occur and east of the Salitre Ranch the same *Orbicella* was found as that occurring southeast of San Rafael, together with specimens of a new genus of the fungid corals. At and around Salitre were found three species of echinoderms (*Agassizia clevei* Cotteau, *Clypeaster cubensis* Cotteau, *Clypeaster,* sp. *b* occur at Localities x24 and x25. R. E. D.), the only ones so far found in beds we have recognized as Oligocene.

A range of hills known as the Martines which are similar to those seen east of San Jose de las Rusias and of about equal height is found here extending from Salitre southward nearly to the Soto la Marina River. Along the Conchos River the exposures of the Oligocene are of beds higher in the series than the bulk of those of San Jose de las Rusias, being represented in that region by the Pecten beds which lie along its extreme eastern border. In the valley of the Conchos the greenish clays and soft sands with their beds of gypsum, which are part of the Frio, are found as far east as Tepetate and forming the body of the hills lying directly north. Beds of the Oligocene are found not only overlying these beds at this point, but stretching several miles westward, showing a clear overlap to lower beds of the Eocene section.

What seem to be the lowest beds of the San Fernando section were found three miles west of that town, and consist of cross-bedded gray sandstones with a thickness of 60 feet. Half a mile east the beds form a series of falls in the river and we have the following section:

	Feet
Conglomerate	4
Cross-bedded sandstone indurated and with bands of fossils	70
Yellowish sandstones with fossils	3
Gray sandstones weathering in holes, few fossils	4

The cross-bedded sandstone carries a great number of a large Pecten, which are well preserved, and, as it appears to be a well-marked horizon, we have called it the Pecten bed. (Locality x4. *Pecten condylomatus* Dall, *Pecten levicostatus* Toula, *Pecten gatunensis* Toula occur here. R. E. D.) It is immediately overlain by beds of sandy clay with fragments of shells, a well-preserved large gasteropod, and numerous claws of a crustacean.

Fauna

Most of the localities listed below appear to belong to the San Fernando formation of Dumble. A very meagre fauna was obtained from localities x37 and x38 but it appears to be of Pliocene or Pleistocene age. *Orbitoides* cf. *papyracea* was obtained from localities x59 and x64 and these localities probably represent a lower Oligocene phase corresponding to the Vicksburg. Unfortunately no mollusca were found with these forms. This list indicates the faunal relations of certain forms satisfactorily. The faunas from localities x14 and x24 are the keys to the relationship of the echinoderms and mollusks of known range. Thus locality x14 yielded *Cidaris* cf. *loveni,* sp., *Clypeaster cubensis* Cotteau, *Macropneustes antillarum* Cotteau, *Astarte,* sp., *Cardium,* sp., *Cardium lingua-leonis* Guppy, *Glycimeris,* sp., *Meretrix,* sp., *Ostrea trigonalis* Conrad, *Panope,* sp., *Pecten gatunensis* Toula, *Tellina,* sp., *Petalochoncus,* sp., *Hemipristis serra* Agassiz, *Architectonica,* sp., *Conus interstinctus* Guppy, *Cypræa,* sp., *Malea ringens* Swainson, *Sinum,* sp., *Turritella,* sp., *Urosalpinx (?)* sp., *Xenophora,* sp.

Conus interstinctus and *Cardium lingua-leonis* are forms characteristic of the Bowden beds; *Pecten gatunensis* and *Pecten levicostatus* are found in the Gatun horizons and *Pecten condylomatus* is a species previously reported from the Chattahoochee and Chipola horizons of Florida. The faunas from the Chattahoochee, Chipola, Bowden, and Gatun horizons represent somewhat different stages—or possibly facies, in part—of a great faunal assemblage which lived during a great period of submergence following the epi-Vicksburg interval. The occurrence of *Clypeaster cubensis* and *Macropneustes antillarum* with these mollusks of known range demonstrates that they are members of the Bowden fauna. *Hemipristis serra,* a shark's tooth which occurs typically in the Miocene of Maryland and the Miocene of California is also reported at this locality.

Locality x24 yielded *Agassizia clevei* Cotteau, *Clypeaster,* sp. *b*(?), *Clypeaster cubensis* Cotteau, *Lovenia dumblei,* n. sp., *Ostrea,* sp., *Pecten gatunensis* Toula, *Ficus mississippiensis*

	×119	×120	×129	×130	
Orbitoides, sp.	....	....	....	....	.....
Agassizia clevei Cotteau	....	....	....	....	.....
Cidaris cf. loveni Cotteau	....	....	....	....	.....
Clypeaster, sp. b.	....	....	....	....	.....
Clypeaster cubensis Cottean	....	....	....	....	.....
Clypeaster, sp. a.	....	....	....	×	M×83
Clypeaster, sp. indet.	×	×	×	×	M×79
Clypeaster cf. concavus Cottea	....	....	....	..	.....
Eupatagus, sp.	....	....	....	×	.....
Lovenia dumblei, n. sp. Kew	....	....	....	....	.....
Macropneustes antillarum Co	....	....	....	....	.....
Macropneustes mexicanum, n	....	....	....	×	.....
Metalia cumminsi, n. sp. Ke	....	....	....	....	.....
Scutella cazonesensis, n. sp. I	....	....	....	....	.....
Schizaster scherzeri Gabb	....	....	....	....	.....
Schizaster clevei Cotteau	....	....	....	....	.....
Astarte, sp.	....	....	....	....	.....
Arca, sp.	....	....	....	....	.....
Arca trinitaria Guppy	....	....	....	....	.....
Antigona glyptoconcha Dall	....	....	....	....	.....
Cardium, sp.	....	....	....	....	.....
Cardium gatunense Toula	....	....	....	....	.....
Cardium lingua-leonis Guppy	....	....	....	....	.....
Clementia cf. dariena Conrad	....	....	....	....	.....
Chione cf. ballista Dall	....	....	....	....	.....
Glycimeris, sp.	....	....	....	....	.....
Meretrix, sp.	....	....	....	....	.....
Mya, sp.	....	....	....	....	.....
Macoma (?) sp.	....	....	....	....	.....
Ostrea haitiensis Sowerby	....	....	....	....	.....
Ostrea trigonalis Conrad	....	....	....	....	.....
Ostrea virginica Conrad	....	....	....	....	.....
Ostrea, sp.	....	....	....	....	.....
Paphia (?) sp.	....	....	....	....	.....
Panope, sp.	....	....	....	....	.....
Pecten gatunensis Toula	....	....	....	....	.....
Pecten cf. gatunensis Toula	....	....	....	....	.....
Pecten condylomatus Dall	....	....	....	....	.....
Pecten, sp.	....	....	....	....	.....
Pecten oxygonum optimum B.	....	....	....	....	.....
Pecten levicostatus Toula	....	....	....	....	.....
Pecten, sp.	....	....	....	....	.....
Tellina, sp.	....	....	....	....	.....
Architectonica, sp.	....	....	....	....	.....
Amphissa, sp.	....	....	....	....	.....
Conus interstinctus Guppy	....	....	....	....	.....
Conus, sp.	....	....	....	....	.....
Cypræa, sp.	....	....	....	....	.....
Ficus mississippiensis Conrad	....	....	....	....	.....
Malea ringens Swainson	....	....	....	....	.....
Malea, sp.	....	....	....	....	.....
Melongena, sp.	....	....	....	....	.....
Natica, sp.	....	....	....	....	.....
Oliva, sp.	....	....	....	....	.....
Olivella, sp.	....	....	....	....	.....
Sinum, sp.	....	....	....	....	.....
Turritella, sp.	....	....	....	....	.....
Turritella altilira Conrad	....	....	....	....	M×73
Urosalpinx (?) sp.	....	....	....	....	.....
Xenophora, sp.	....	....	....	....	.....

LIST OF SPECIES FROM THE SAN FERNANDO FORMATION AND ASSOCIATED BEDS

	×3	×4	×5	×14	×21	×22	×23	×24	×25	×29	×30	×31	×32	×33	×34	×35	×36	×37	×38	×40	×42	×43	×44	×59	×62	×63	×64	×118	×119	×120	×129	×130	
Orbitoides, sp																								×			×						
Agassizia clevei Cotteau								×	×	×																							
Cidaris cf. loveni Cotteau				×																													
Clypeaster, sp. b						×														×													
Clypeaster cubensis Cotteau				×							×				×																		
Clypeaster, sp. a								×																								×	M×83
Clypeaster, sp. indet								×																				×	×	×	×	×	M×79
Clypeaster cf. concavus Cotteau																			×														
Eupatagus, sp																																×	
Lovenia dumblei, n. sp. Kew							×	×	×																×	×							
Macropneustes antillarum Cotteau				×										×																			
Macropneustes mexicanum, n. sp.																																×	
Metalia cumminsi, n. sp. Kew							×																										
Scutella cazonesensis, n. sp. Kew							×																										
Schizaster scherzeri Gabb				×																					×								
Schizaster clevei Cotteau																									×								
Astarte, sp				×																													
Arca, sp		×																															
Arca trinitaria Guppy		×																															
Antigona glyptoconcha Dall																				×													
Cardium, sp				×							×				×																		
Cardium gatunense Toula	×	×																			×												
Cardium lingua-leonis Guppy				×																													
Clementia cf. dariena Conrad		×																															
Chione cf. ballista Dall																×																	
Glycimeris, sp				×																													
Meretrix, sp		×		×																													
Mya, sp											×																						
Macoma (?) sp		×																															
Ostrea haitiensis Sowerby											×												×										
Ostrea trigonalis Conrad				×							×																						
Ostrea virginica Conrad																		×	×														
Ostrea, sp		×					×	×																									
Paphia (?) sp													×																				
Panope, sp				×																													
Pecten gatunensis Toula		×		×	×	×		×			×						×				×	×			×								
Pecten cf. gatunensis Toula		×																															
Pecten condylomatus Dall		×	×					×			×		×				×				×	×											
Pecten, sp								×																									
Pecten oxygonum optimum B. & P.							×																										
Pecten levicostatus Toula		×																															
Pecten, sp																			×														
Tellina, sp				×																													
Architectonica, sp				×																													
Amphissa, sp		×																															
Conus interstinctus Guppy				×																													
Conus, sp											×																						
Cypræa, sp				×																													
Ficus mississippiensis Conrad								×																									
Malea ringens Swainson				×																													
Malea, sp											×				×																		
Melongena, sp								×																									
Natica, sp								×			×				×																		
Oliva, sp																			×														
Olivella, sp		×																															
Sinum, sp													×																				
Turritella, sp		×		×																													M×73
Turritella altilira Conrad																																	
Urosalpinx (?) sp				×																													
Xenophora, sp				×																													

Conrad, *Melongena*, sp., *Natica*, sp. Of these, *Ficus mississippiensis* has been found from the Vicksburg horizon and from the Bowden beds; *Pecten gatunensis* is a characteristic form from the Panama Canal Zone. Thus *Agassizia clevei* and *Lovenia dumblei* are proved to be associates of these characteristic species of the Bowden stage and representative fossils of the medial Tertiary of Mexico.

We are now able to determine the species characteristic of the San Fernando beds by using *Agassizia clevei, Lovenia dumblei, Macropneustes antillarum, Clypeaster cubensis, Pecten gatunensis*, and *Pecten condylomatus* as our guide fossils. The forms specifically determined are as follows: *Agassizia clevei, Clypeaster cubensis, Lovenia dumblei, Macropneustes antillarum, Metalia cumminsi, Schizaster scherzeri, Arca trinitaria, Antigona glyptoconcha, Cardium gatunense, Cardium lingua-leonis, Ostrea haitiensis, Ostrea trigonalis, Pecten gatunensis, Pecten condylomatus, Pecten oxygonum optimum, Pecten levicostatus, Conus interstinctus, Ficus mississippiensis, Malea ringens* and *Turritella altilira*. The great number of echinoids and their widespread distribution is due in part at least, to deposition near the shore-line. All the above echinoids should prove to be good horizon markers when carefully determined. *Macropneustes antillarum* and *Agassizia clevei* were described from beds of supposed Eocene age of St. Bartholomew and Cuba, but their association here with forms characteristic of the Bowden horizon proves that they are members of this fauna.

Conclusions

(1) The fauna of the medial Tertiary beds of northeastern Mexico is a littoral facies of the Bowden or Chattahoochee horizons.

(2) *Clypeaster cubensis, Agassizia clevei, Lovenia dumblei, Pecten condylomatus, Pecten oxygonum optimum, Pecten gatunensis*, are the best guide fossils of the medial Tertiary.

List of Localities Yielding Tertiary Fossils From Northeastern Mexico

x3 San Rafael, Tampico, Mexico, May 16, 1907. W. F. Cummins.

x4 On San Fernando River near San Fernando, Tamaulipas, Mexico. Coll., Prof. W. F. Cummins.

x5 San Jose de las Rusias, 1 mile east.

x14 Tuxpan, State of Vera Cruz, Mexico. 9/15/1908. Colls., Prof. E. T. Dumble and Prof. W. F. Cummins.

x21 Hill one mile east of San Jose de la Rusia Ranch. Colls., Cummins and Sands.

x22 Hills four miles north of San Rafael. Colls., Cummins and Sands.

x23 Twelve miles east of San Rafael on Zarizal River where salt water joins fresh. Colls., Cummins and Sands.

x24 Salitre Ranch. April 1, 1909. Colls., Cummins and Sands.

x25 Salitre, one mile, North.

x29 Salitre, one mile, North.

x30 Hills north of Tuxpan, State of Tampico, Mexico, Oct. 25, 1909. Colls., Cummins and Sands.

x31 Kilometer 32, C. F. R. R., near Cazones River, Region de Papantla.

x32 Kilometer 35, C. F. R. R., near Cazones River, Region de Papantla.

x34 One mile N. of Tampico and on opposite side of Laguna de Carpintero from it. Coll., W. H. Steeruwitz.

x35 Mt. Huitepec near Salteros, Region de Papantla.

x36 Arroyo Hondo on road Larios to Questeponapa, Vera Cruz, Mexico. Colls., Cummins and Sands.

x37 Kilometer 15. C. F. R. R. About 15 miles south of Tuxpan.

x38 One mile northwest of Tampico. Oct. 5, 1909. Colls., Cummins and Sands.

x40 Three miles directly west of Larios, Vera Cruz. Oct. 18, 1909. Colls., Cummins and Sands.

x42 Kilometers 39-41. Cobos and Farbero Railroad, State of Vera Cruz, Mexico. Oct. 22, 1909.

x43 San Pablo half way between Guitierez, Zamora and Papinka, Vera Cruz. Oct. 20, 1909. Colls., Cummins and Sands.

x44 C. F. R. R. Cazones River, Region de Papantla.

x57 Two miles northeast of Tampico. Corals. Colls., Cummins and Sands.

x59 About seven miles west of San Marco, Region de Tuxpan. Aug. 5. Coll., W. F. Cummins.

x62 Nuevo Rancho. Coll., W. F. Cummins.

x64 Morales.

x118 Cut on street railway between Dona Cecelia and Tampico, State of Tamaulipas.

x119 Blown out of Waters Pierce Well No. 5—Topila, Vera Cruz, Oct., 1915.

x123 West of Montemorales.

x128 Debris washed from hill at Waters Pierce Well No. 5—Topila, Vera Cruz, Muir's numbers Mx21 to Mx35.

x129 Penultimate hill on northwest end of La Puerte Range, Topila, Muir's numbers Mx36 to Mx52.

x130 Hill at extreme north end of La Puerte Range, Topila. Muir's numbers Mx53 to Mx70.

DESCRIPTION OF SPECIES

Clypeaster cubensis Cotteau

Plate 20, fig. 1; plate 21, fig. 1

Clypeaster cubensis Cotteau, 1876. Description Echinides Tertiare des Isles Saint Barthelemy et Anguilla, Kongliga Svenska Vetenskaps-Akademiens Handlingar, Bd. 13, no. 6, p. 6.

Geologic Horizon:—Upper Oligocene or Lower Miocene.

Localities:—x14, x30, x34 (Rio Bravo Oil Company's numbers).

Scutella cazonesensis, new species

Plate 19, fig. 1

Test of large size (approximate anteroposterior diameter, 105 mm., approximate transverse diameter 111 mm.); marginal outline subcircular with prominent, deep, angular notch in the odd posterior interambulacrum, and with ambulacral areas truncated or faintly and broadly notched. Test strongly depressed and markedly thin. Apical system central. Ambulacra petaloid; petals symmetrical, of moderate size, and extending about two-thirds the distance from the apical system to the margin. In petals of the trivium, the interporiferous area is about two-thirds the entire width of the petal; interporiferous area of the bivium narrower, equal in width to one-half the petal. Inner rows of elongate pores diverge gradually for about two-thirds the length of the petal, and then converge slightly to the end; outer rows of very small round pores converge to a greater degree at the extremity of the petal, and close with the inner rows; pores conjugate. Petals half open at their ends. Genital pores small; pores in radial plates relatively large. Tuberculation on the superior surface of the test consists of minute crowded scrobicular tubercles. Periproct very small (1.5 mm. in diameter), and situated about 4 mm. from the margin on the under surface.

This species is similar to *Scutella aberti* Conrad, but is distinguished by having narrower poriferous areas in the petals

with correspondingly greater width of the interporiferous area.

Geologic Horizon:—Upper Oligocene or Lower Miocene.

Type:—No. 369, Cal. Acad. Sci.

Type Locality:—X32 (Rio Bravo Oil Company's number), kilometer 35, C. F. R. R., near Cazones River, Region de Papantla, Mexico.

Metalia cumminsi, new species.

Plate 21, fig. 2; plate 22, fig. 1; plate 23, fig. 1.

Test of large size (antero-posterior diameter, 91 mm., transverse diameter, 77 mm., greatest height, 28 mm.); marginal outline suboval, elongate anteroposteriorly, truncated behind and with broad, indistinct notch in the odd anterior ambulacrum; edge of test relatively thin. Apical system excentric to the anterior of the center of the test; apex immediately in front of the apical system. Odd anterior ambulacrum in a feeble depression, the depressed area extending to the outer edges of the adjoining interambulacral areas; ambulacral areas narrow, and widening gradually to the ambitus; very small pairs of pores situated in the center of each plate. Anterior lateral interambulacral plates wider on the side next to the odd ambulacrum than on the opposite side. Anterior lateral ambulacra one-half as wide at the margin as the odd anterior one. Posterior lateral interambulacral areas wide. Paired ambulacra petaloid; petals of the same length and narrow; posterior rows of pores in lateral petals extend in straight lines, but the anterior rows diverge from the others until one-half the distance from the apical system to the end of the petal and then converge close to the posterior rows. Poriferous areas wide, each being about equal in width to the interporiferous area. Pores large, the outer ones more elongate than the inner ones. Petals placed in broad, moderately deep grooves; interambulacral areas somewhat raised on the upper surface and with anterior lateral areas flattened. Actinal surface flat with wide prominent amphisternum. A continuation

of the odd anterior ambulacral depression to the peristome, near which it becomes deeper, is present on the under side. Peristome, large, semi-circular, and with prominent posterior labrum which merges posteriorly with the amphisternum. Periproct large and supramarginal. A sinuous peripetalous fasciole is present; also a broad, distinct, cordate, subanal fasciole. Prominent perforated tubercles, limited by the peripetalous fasciole on the upper surface, are present on the posterior plates of the interambulacra; odd posterior interambulacrum not shown in the specimen at hand. On the under surface the tubercles are large and for the most part uniform in size, but are slightly smaller on the amphisternum; those enclosed by the subanal fasciole are arranged in radiating rows; smaller primaries are present on the interambulacral plates adjacent to the odd ambulacrum. The remainder of the surface is covered with secondaries and granules.

Geologic Horizon:—Upper Oligocene or Lower Miocene.

Type:—No. 371, Cal. Acad. Sci.

Type Locality:—X23 (Rio Bravo Oil Company's number), twelve miles east of San Rafael on Zarizal River, where the salt water joins the fresh. Colls., Prof. W. F. Cummins and Mr. Sands.

Named for Professor W. F. Cummins.

Macropneustes mexicanus, new species.

Plate 24, fig. 3; plate 25, figs. 1a, 1b.

Test of large size (anteroposterior diameter, 76.4 mm.; transverse diameter, 68.9 mm.; greatest height, 34.8 mm.); tumid and with rounded margin. Marginal outline suboval, slightly angulated, broader and more rounded in the anterior part; posterior end truncated; broad shallow groove in the odd anterior ambulacral area. Ambulacra and interambulacra of varying widths at the ambitus; odd anterior one, very narrow; lateral paired areas of equal widths, being about one-half that of the posterior paired interambulacra; anterior, paired interambulacra narrower and with the plates adjoining

the odd ambulacrum one-half the width of the opposite ones; odd posterior interambulacrum slightly narrower than the posterior lateral pair. Lateral ambulacra petaloid; pores attain their maximum divergence rapidly, and then continue in parallel lines, the rows extending about seven-tenths the distance from the apical system to the ambitus; posterior pair of petals diverge from each other in curving lines; anterior pair curve forward, the degree of curving being greater within the last half of their length. Interporiferous area equal to each poriferous area. Petals semi-flush with the surface of the test. Pores large and oval in outline; those close to the apical system, very small and undeveloped. Pores of lateral petals extend beyond their extremities and continue irregularly to the peristome. Odd anterior ambulacrum possesses a very small pair of pores in each plate, this character extending from the apical system to the peristome. Apical system excentric to the anterior of the center of the test; is very small and contains four relatively large genital pores, crowded together. Upper surface of test arching slightly and with interporiferous areas somewhat raised above the surface; apical system depressed. Inferior surface slightly convex; peristome situated near the anterior margin, large, crescent-shaped and with prominent labrum which is followed posteriorly by a low broad amphisternum. Periproct situated on the posterior truncation of the test, and is larger than the peristome; outline subcircular, but with transverse diameter slightly greater than the anteroposterior diameter. Tuberculation consists of a few large primaries on the interradial areas and medium sized tubercles crowded together on the under surface. Peripetalous and subanal fascioles present. The finer features can not be distinguished on this specimen, due to weathering.

This species may be distinguished from other forms of *Macropneustes* by the curving of the petals.

Geologic Horizon:—Upper Oligocene or Lower Miocene.

Type:—No. 375, Cal. Acad. Sci.

Type Locality:—MX-130 (Rio Bravo Oil Company's number), hill at extreme north end of La Puerte Range, Topila, Mexico. Coll., Mr. Muir.

Lovenia dumblei, new species.

Plate 17, figs. 2a-2c.

Test of moderate size (anteroposterior diameter, 47.5 mm.; transverse diameter, 46 mm.; average greatest elevation, 18.5 mm.); marginal outline sub-cordiform to sub-oval, slightly angulated. Abactinal surface nearly flat, but with greatest elevation in the posterior portion of the test; odd anterior interambulacral area somewhat ridged. Ambitus of odd anterior ambulacrum deeply notched; posterior end truncated. Apical system excentric slightly to the anterior of the center of the test; furnished with four large genital pores crowded together, the two posterior ones being farther apart than the anterior pair; madreporic area extends from between the pores, posteriorly into a lobe. Paired petals of equal length; aborted near the apical system by the internal fasciole; anterior rows of the pores of the anterior lateral petals form a nearly transverse line. Petals pointed, subtriangular in shape, and curving slightly to the front. Pores large, suboval, and conjugated; within the internal fasciole, rudimentary petals are present which extend from the apical system to the fasciole, but do not connect with the normally developed petals outside. Poriferous areas of equal width for the entire distance. Beyond the ends of the antero-lateral petals a double row of small pores continues past the margin to the peristome. Pores of the odd anterior petal small, obliquely placed, set close together, and located in the center of each plate; they continue from the apical system in slightly divergent lines to the ambitus and then converge to the peristome; this system of pores is not interfered with by the internal fasciole. The odd anterior groove is shallow on the upper surface, but becomes more pronounced near the margin and cuts the ambitus in a deep angular notch, passing on the under side to the peristome. Paired petals slightly depressed. Actinal surface slightly concave to the peristome. Amphisternum broad and indistinct in the posterior part, but becoming narrower and more prominent to the anterior, culminating in a well-defined protruding labrum. Peristome situated well toward the anterior portion of the test, large and pentagonal in outline; well defined phyllode present. Periproct large, suboval

and not depressed. The tuberculation consists of large primary tubercles on the lateral interambulacral areas of both the upper and lower surfaces, and in some specimens they are sparsely present on the odd posterior interambulacrum; large primaries are lacking on the marginal area; all are deeply scrobicular, and with perforated mamelon, the latter protruding above the general level of the test. Secondaries, perforated, and possessing a poorly developed scrobicule; these are situated within the area surrounded by the internal fasciole, on the marginal area, on the elevated portion of the odd posterior interambulacral area, along the odd anterior ambulacral area, and around the periproct and subanal areas. Milliaries are spread over the entire test; these vary somewhat in size, and are irregular in their distribution. Internal fasciole circumscribes a relatively large area; it is undulating, broad, and very distinct except where it crosses the odd anterior ambulacral area, at which place it is either absent or weakly developed. A transversely elongate subanal fasciole is present.

Geologic Horizon:—Upper Oligocene or Miocene.

Localities:—X23, X24, X25, X62, X63 (Rio Bravo Oil Company's numbers).

Type:—No. 364, and cotypes Nos. 365 and 366, Cal. Acad. Sci.

Type Locality:—X62 (Nuevo Rancho, 35 kilometers northwest of Tuxpan, near Cerro Azul. Coll., W. F. Cummins. Cotype localities: X24, Salitre Ranch. Colls., Cummins and Sands; X25, Salitre, one mile north.

Named in honor of Professor E. T. Dumble.

EXPLANATION OF PLATE 17

PAGE

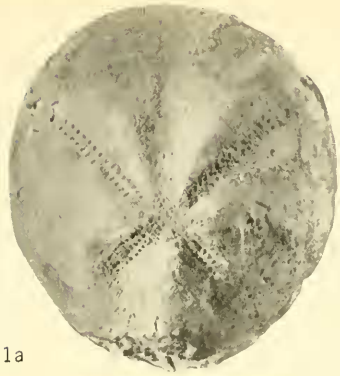
Fig. 1a. Agassizia clevei Cotteau. Upper surface of test. Cal. Acad. Sci. No. 363. $\times \frac{48.5}{29.5}$ 128

Fig. 1b. Agassizia clevei Cotteau. Lateral surface of test. Cal. Acad. Sci. No. 363. $\times \frac{49}{29.5}$ 128

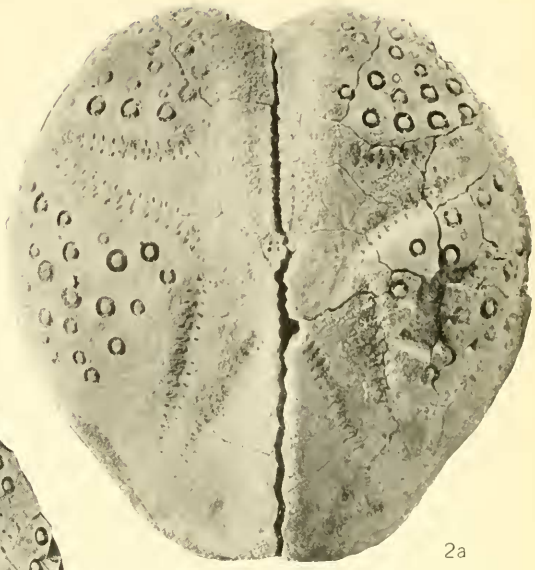
Fig. 2a. Lovenia dumblei Kew. Upper surface of test. Cal. Acad. Sci. No. 364, type specimen. $\times \frac{74}{47.5}$ 136

Fig. 2b. Lovenia dumblei Kew. Upper surface of test. Cal. Acad. Sci. No. 365, cotype. $\times \frac{64}{48.8}$ 136

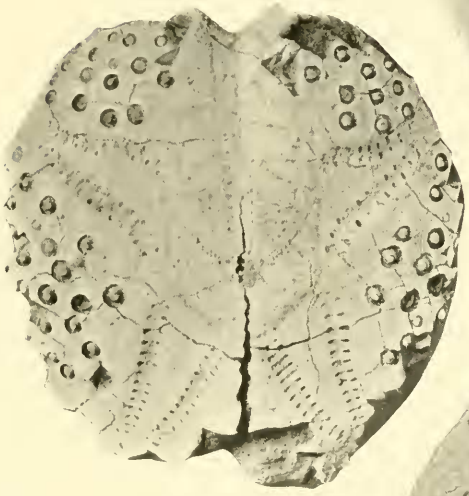
Fig. 2c. Lovenia dumblei Kew. Lower surface of test. Cal. Acad. Sci. No. 366, cotype. $\times \frac{81}{47.2}$ 136



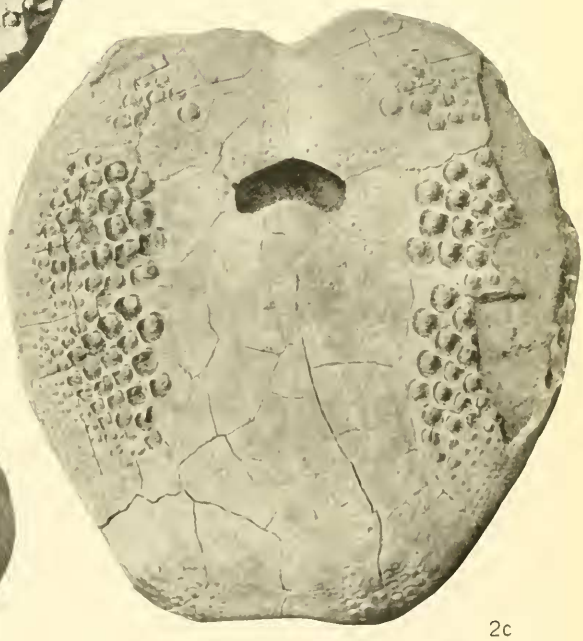
1a



2a



2b



2c

1b

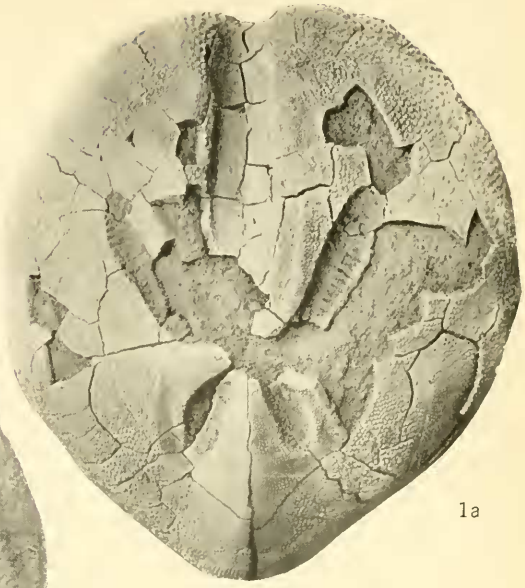
EXPLANATION OF PLATE 18

Fig. 1a. Schizaster clevei Cotteau. Upper surface of test. Cal. Acad. Sci. No. 367. $\times \frac{76}{48.5}$

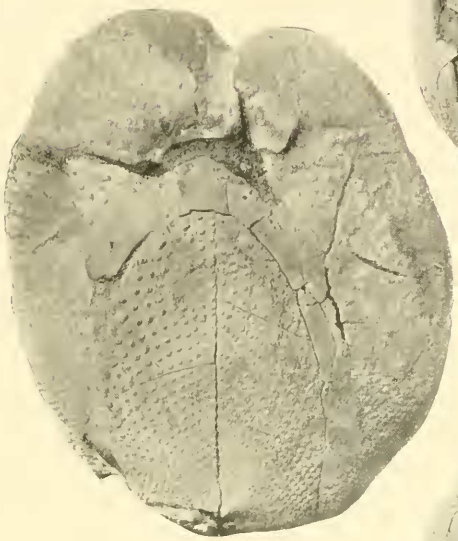
Fig. 1b. Schizaster clevei Cotteau. Lower surface of test. Cal. Acad. Sci. No. 367. $\times \frac{76}{48.5}$

Fig. 1c. Schizaster clevei Cotteau. Lateral surface of test. Cal. Acad. Sci. No. 367. $\times \frac{74}{48.5}$

Fig. 2. Schizaster scherzeri Gabb. Lower surface of test. Cal. Acad. Sci. No. 368. $\times \frac{69}{54}$



1a



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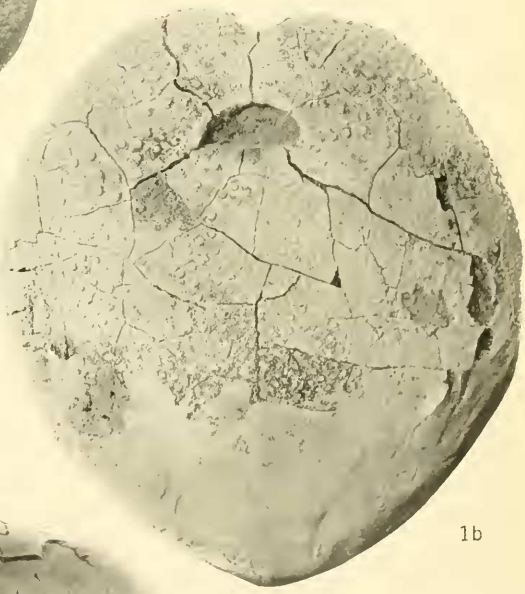


1b

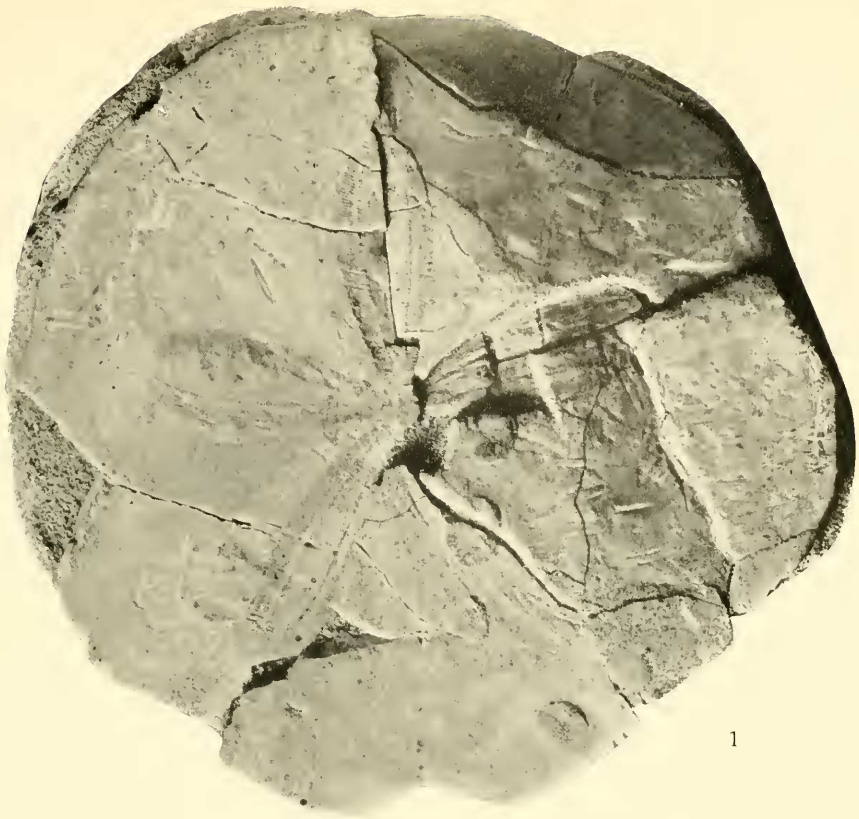
1c

EXPLANATION OF PLATE 19

PAGE

Fig. 1. Scutella cazonesensis Kew. Upper surface of test. Cal. Acad. Sci. No. 369; type. $\times\frac{106}{105}$ 132

Fig. 2. Schizaster scherzeri Gabb. Upper surface of test. Cal. Acad. Sci. No. 368. $\times\frac{82}{54}$ .....



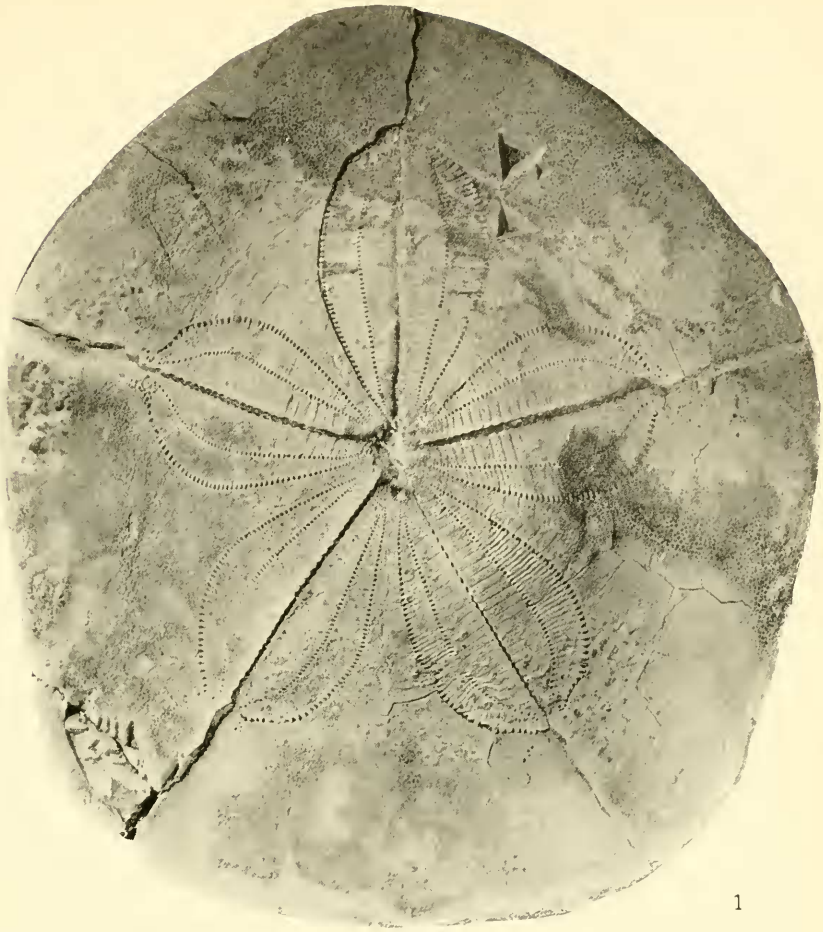
1

2

EXPLANATION OF PLATE 20

Fig. 1. Clypeaster cubensis Cotteau. Upper surface of test. Cal. Acad. Sci. No. 370. $\times \frac{121.7}{147}$.....

Fig. 2. Schizaster scherzeri Gabb. Lateral surface of test. Cal. Acad. Sci. No. 368. $\times \frac{80}{55}$.....



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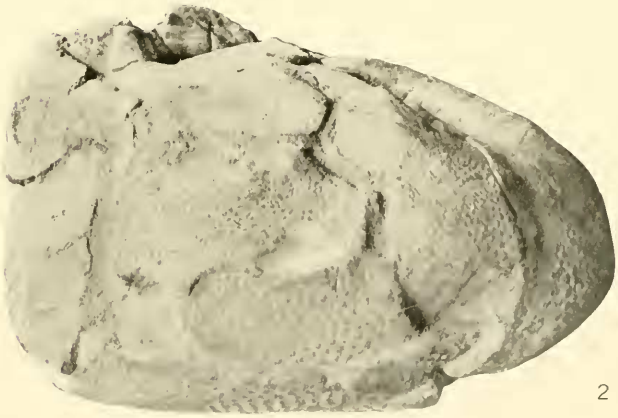

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